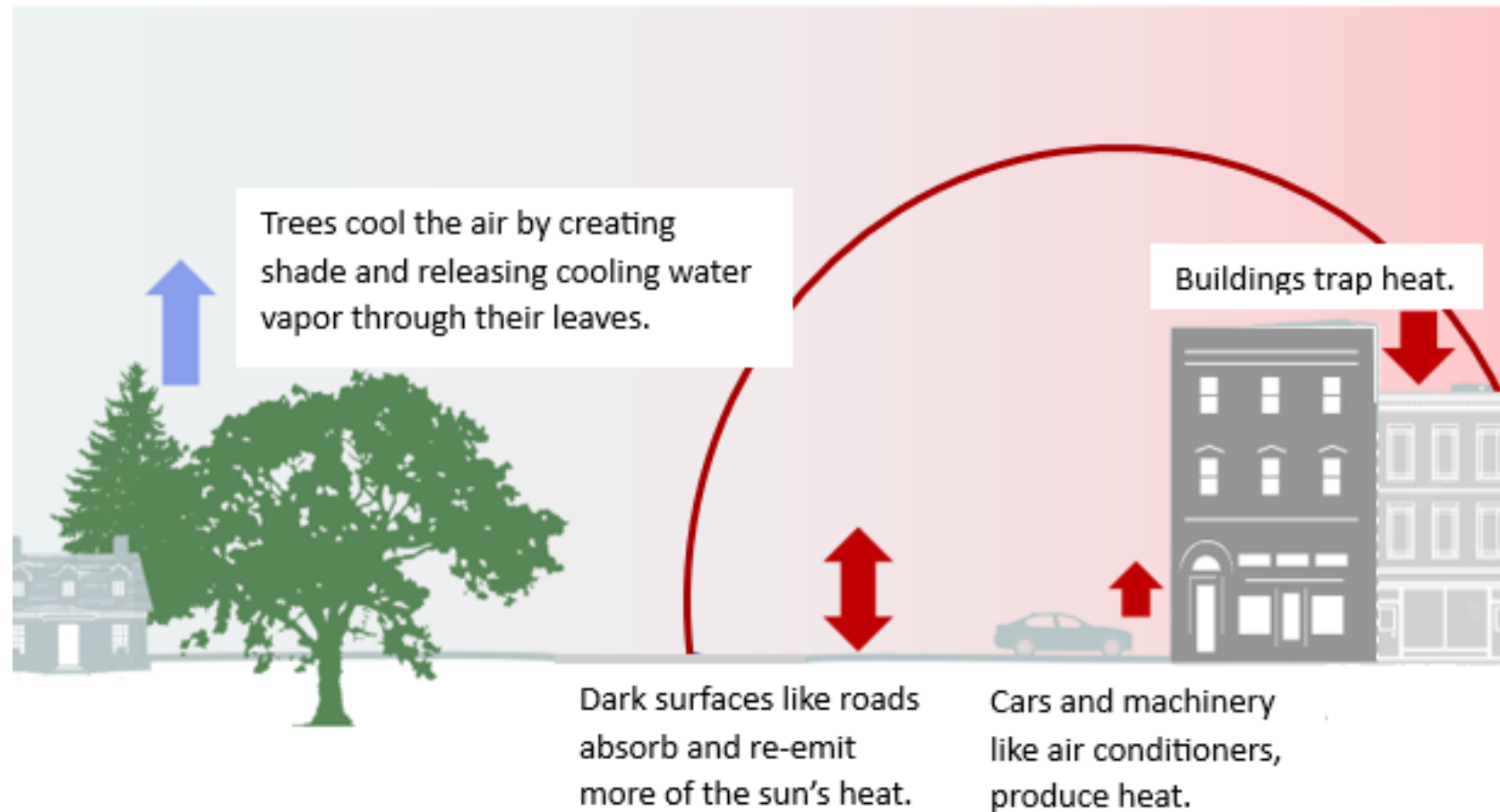


# Urban Heat Island Analysis

Rappahannock-Rapidan  
Regional Commission

# What is an Urban Heat Island?

- Areas of urban land use where observed temperatures were 95°F or greater
- Created by concentrated impervious surfaces

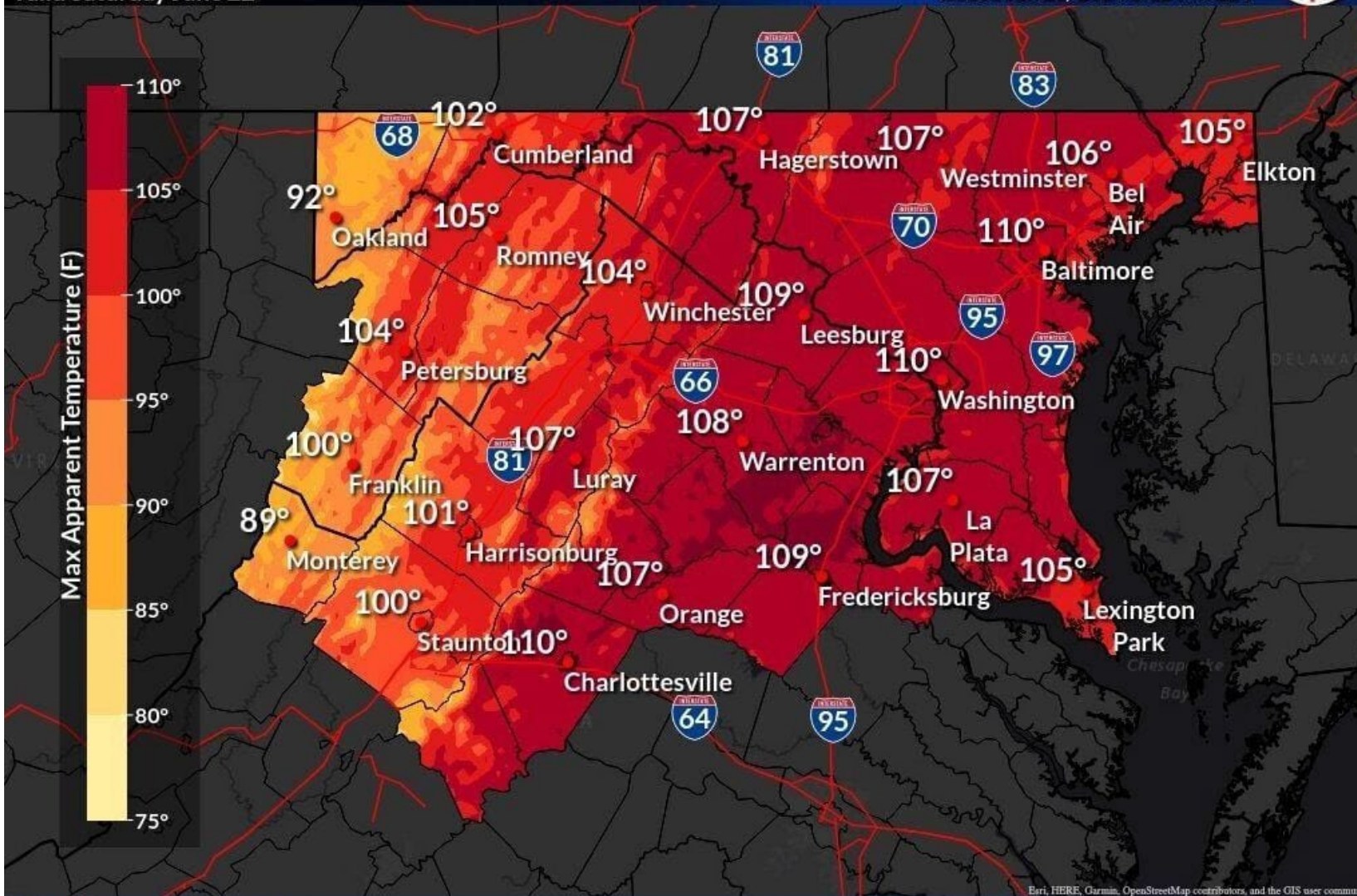


# Maximum Heat Index

Valid Saturday June 22

Weather Forecast Office  
Baltimore/Washington

Issued Jun 20, 2024 5:12 PM EDT







# Analysis Overview

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- WHY: Urban heat islands can negatively impact:
  - Heat-related illness and mortality
  - Energy costs (e.g., for air conditioning)
  - Air pollution levels
  - Water quality and aquatic organisms
- HOW: Used citizen science and GIS to identify heat islands
  1. RRRC worked with FOR to select sampling sites and coordinate volunteers
  2. July 21, 2024 at 3-4pm volunteers recorded air temperatures across the region
    - 22 Sites
    - 314 Samples
  3. RRRC analyzed and mapped the data in GIS
- Funded by: VDOF Urban & Community Forestry Grant



# GIS Mapping

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1. Obtained Landsat 8 Collection 2 Analysis Ready Data (ARD) Level 2 Satellite Imagery, Digital Elevation Model (DEM) tiles, and National Land Cover Dataset (NLCD).
2. Found the Land Surface Temperature (LST) using the raster calculator ArcGIS Pro tool.
3. Found the Normalized Difference Vegetation Index (NDVI) using the raster calculator ArcGIS Pro tool.
4. Air temperature sample data was then entered into a database, and geocoded using GPS locations
5. Found the values of the explanatory rasters (LST, NDVI, NLCD, and DEM) at the air temperature points with the Extract Multi Values to Points ArcGIS Pro tool.
6. Predicted the temperature in the whole study area by running the Forest-based and Boosted Classification and Regression ArcGIS Pro tool.
7. Averaged the predicted LST for all agricultural land cover within study area, and established that the average temperature was 92.1° F.
8. Temperatures between 92.1° F and 94.99° F were considered **Heat Islands**.
9. Temperatures above 95° F in areas of Urban Land Use were considered Urban **Heat Islands**.



# Analysis Results

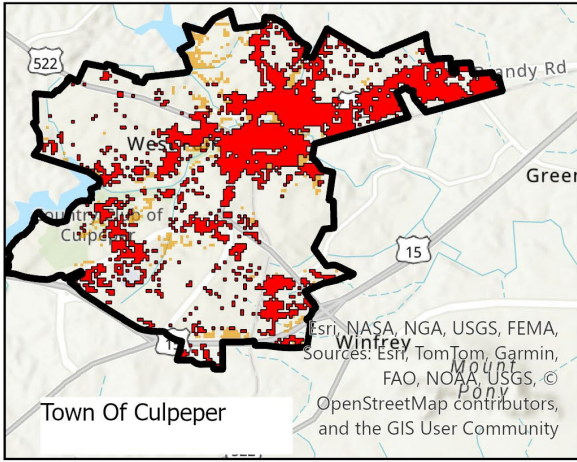
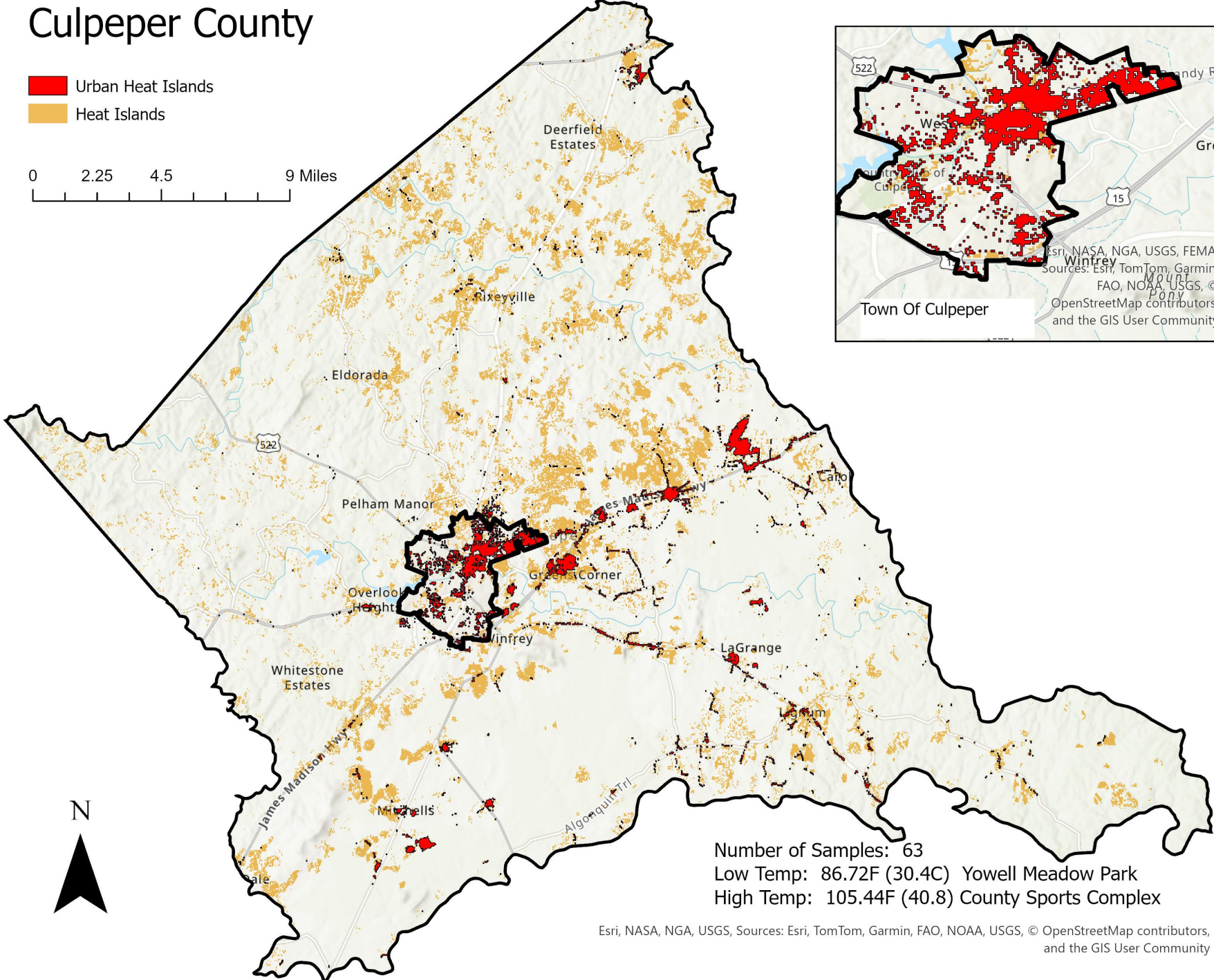
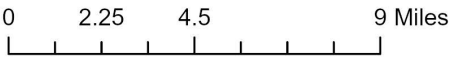
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- The forecast temperature on July 21, 2024 was 89 -91° F
- Low Temperature: 81.68° F (27.6C) at Riverside Preserve in the shade next to Rappahannock River in Fauquier County
- High Temperature: 106.34° F (41.3C) in direct sun on concrete at entrance to Waverly Yowell Elementary School in Madison County
- Average Land Surface Temperature: 91° F



# Culpeper County

- Urban Heat Islands
- Heat Islands

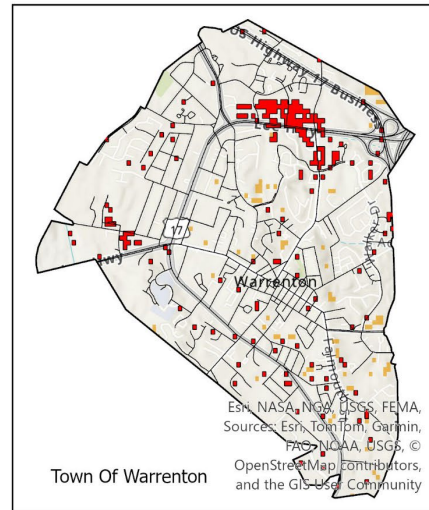


Number of Samples: 63  
Low Temp: 86.72F (30.4C) Yowell Meadow Park  
High Temp: 105.44F (40.8) County Sports Complex

Esri, NASA, NGA, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

# Fauquier County

Urban Heat Islands  
Heat Islands



Number of Samples: 108  
Low Temp: 81.68F (27.6C) Riverside Preserve  
High Temp: 100.94F (38.3C) Warrenton Village Center

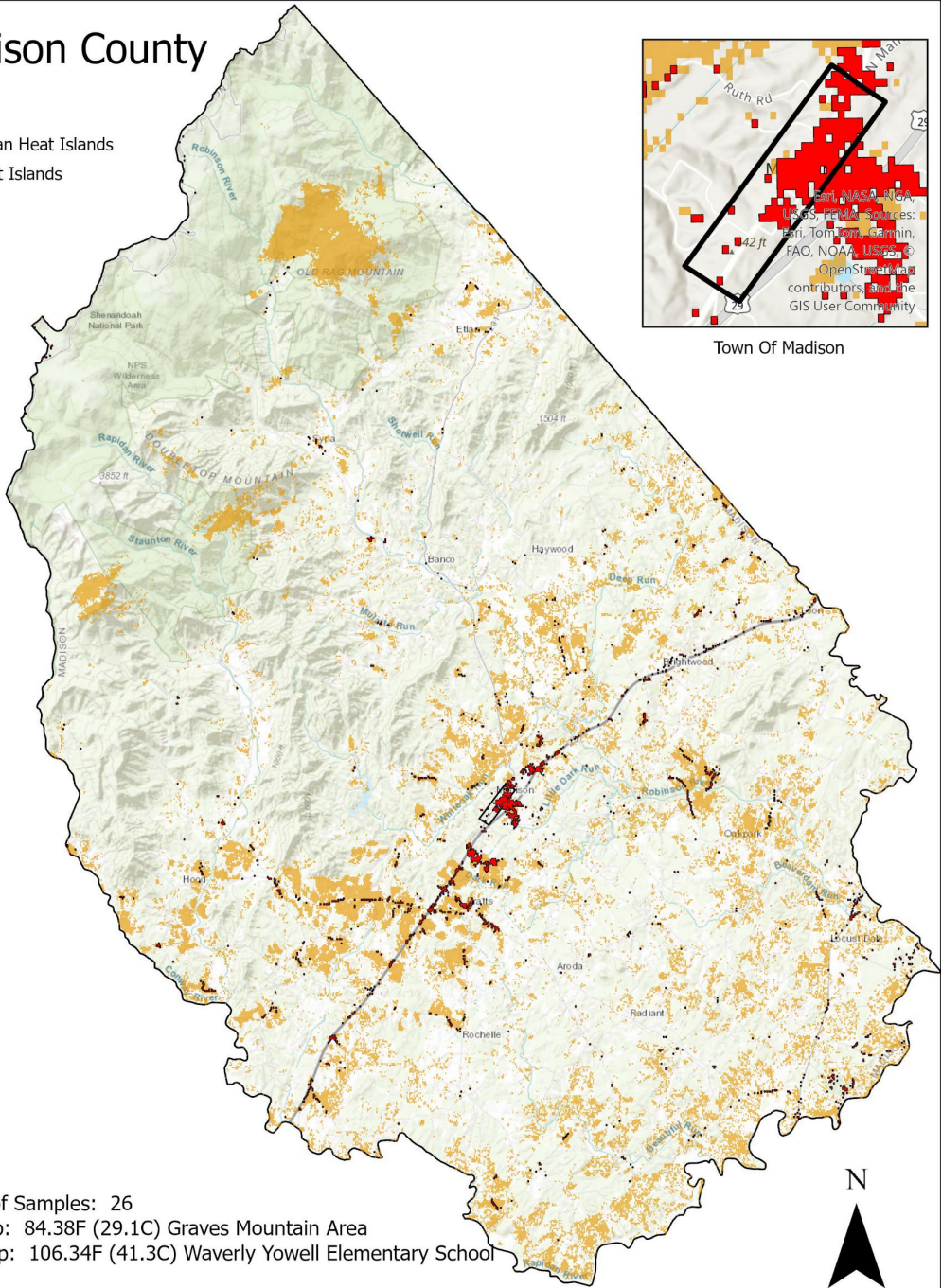
0 3 6 12 Miles

Esri, NASA, NGA, USGS, VITA, West Virginia GIS, Esri, HERE, Garmin, USGS, NGA,  
EPA, USDA, NPS



# Madison County

- Urban Heat Islands
- Heat Islands



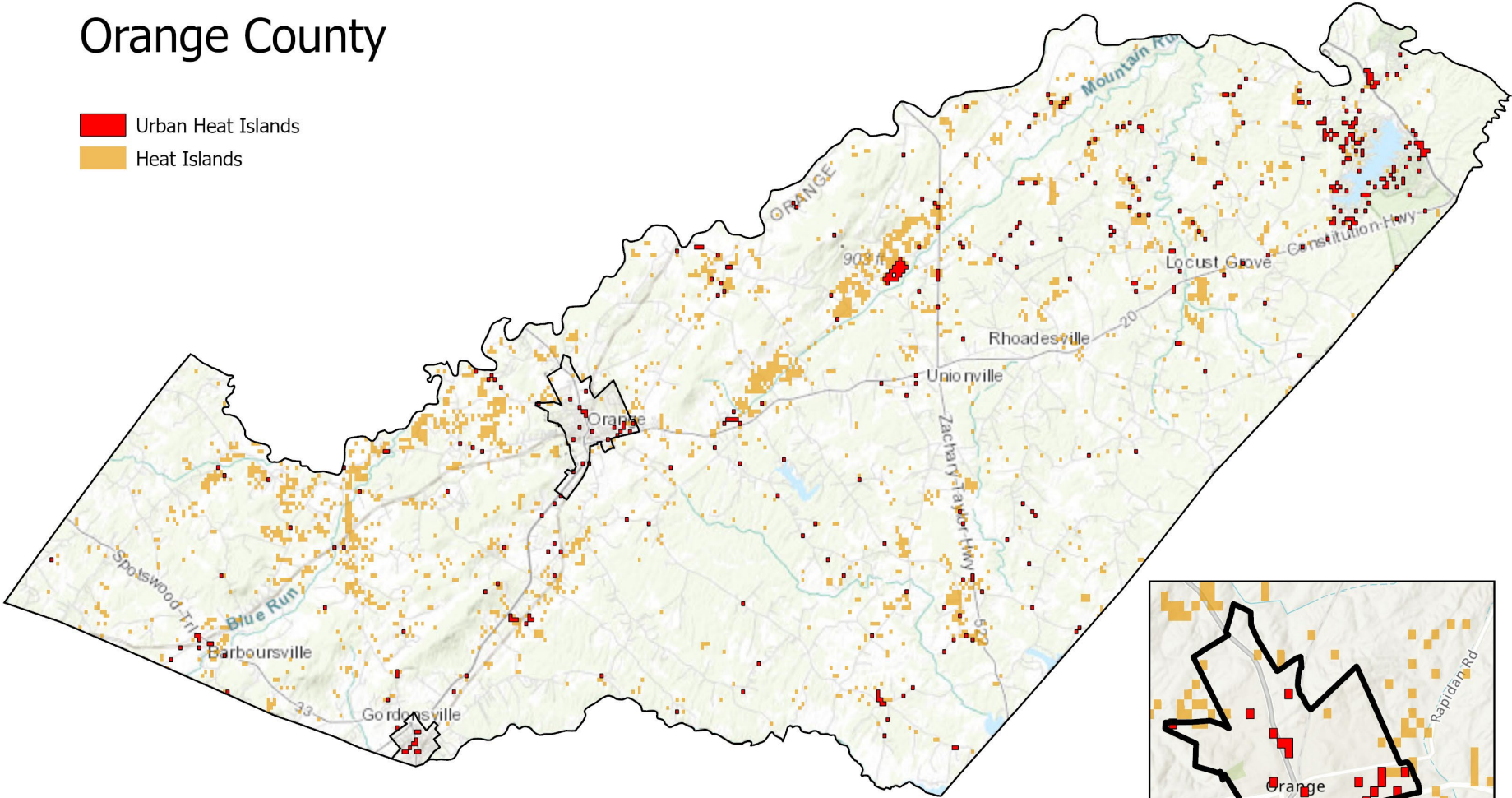
Number of Samples: 26  
Low Temp: 84.38F (29.1C) Graves Mountain Area  
High Temp: 106.34F (41.3C) Waverly Yowell Elementary School

0 1.75 3.5 7 Miles

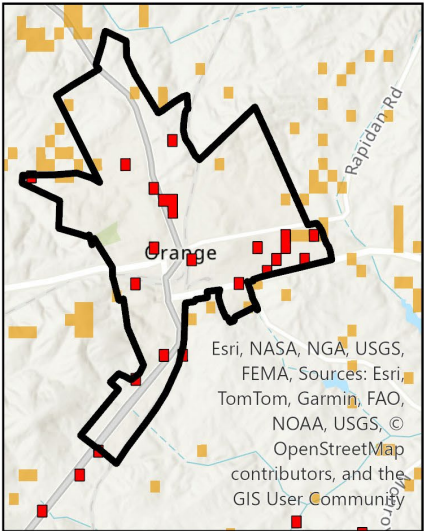
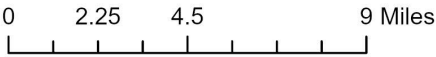
VITA, West Virginia GIS, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, NGA, EPA, USDA

# Orange County

- Urban Heat Islands
- Heat Islands



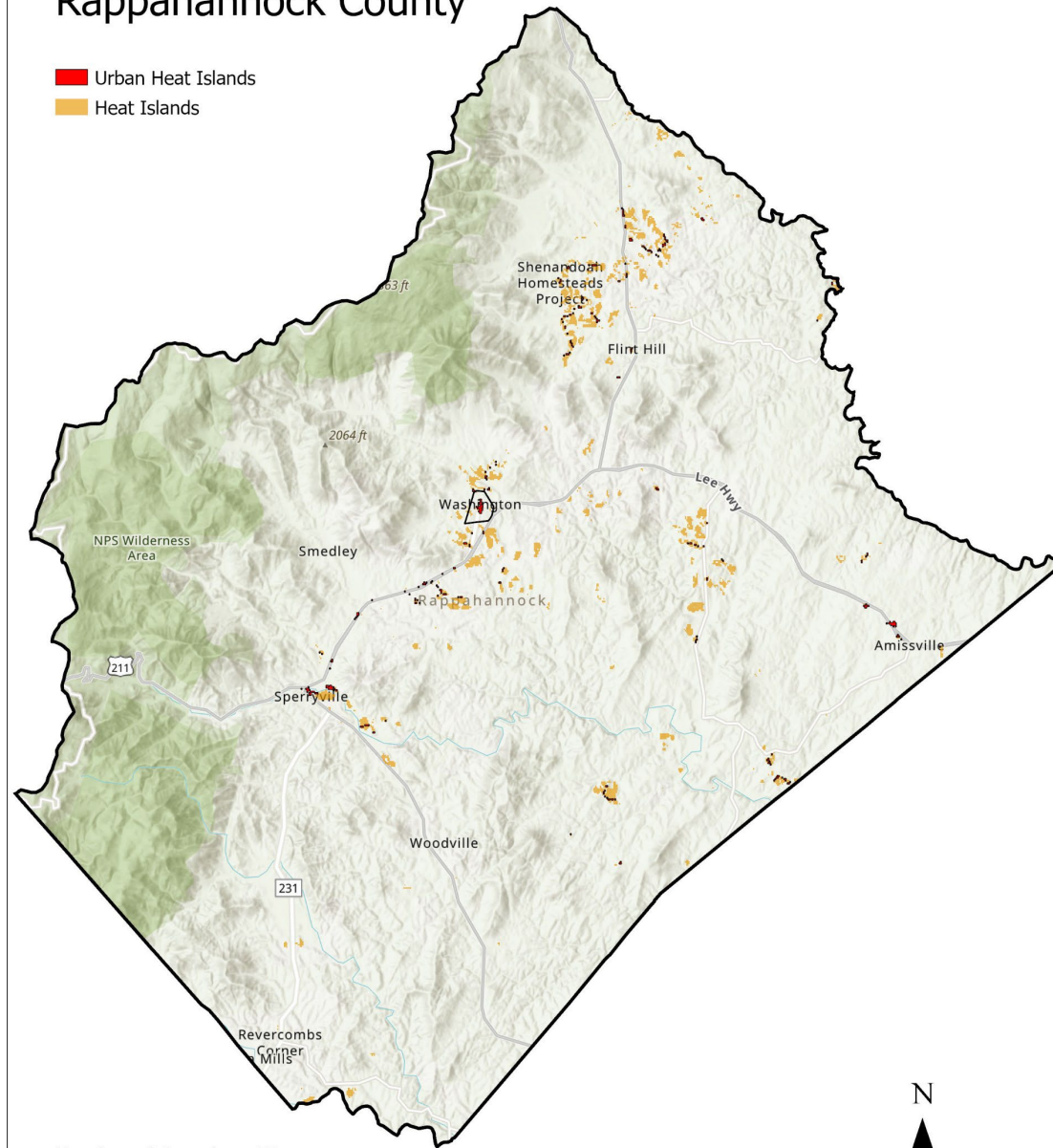
Number of Samples: 45  
Low Temp: 86.72F (30.4C) Locust Grove Wal-Mart Supercenter  
High Temp: 103.82F (39.9C) Barboursville Community Park



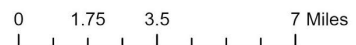


# Rappahannock County

- Urban Heat Islands
- Heat Islands



Number of Samples: 72  
Low Temp: 85.46F (29.7C) Sperryville Fire Department  
High Temp: 102.02F (38.9C) Thornton River Trail



Esri, NASA, NGA, USGS, Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, ©  
OpenStreetMap contributors, and the GIS User Community



# Implementation Options

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- Raise public awareness
- Develop implementation strategies to address hotspots:
  - Tree planting
  - Impervious surface removal
  - Green or cool roofs
  - Solar parking lot canopies
  - Water features
- Planning for green space and trees through zoning, tree preservation ordinances, PDR Programs, green building incentives, etc.
- RRRC, Friends of the Rappahannock and SWCDs are available to provide technical assistance



# Potential Implementation Funding Sources

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- DOF Trees for Clean Water Grant
- SWCD Virginia Conservation Assistance Program (VCAP) cost-share
- VDEQ Stormwater Local Assistance Fund Grant
- National Fish and Wildlife Foundation Small Watershed Grant
- Green Streets, Green Jobs, Green Towns Grant



# Lessons Learned

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- Working with volunteers was both a benefit and a major challenge.
  - Issues with the geocoding accuracy had to be reconciled, due to differences in how people collected their coordinates
  - Fewer sample points in certain areas of the region due to volunteers not showing up
- Environmental challenges were another factor.
  - Difficult to schedule the sampling date far enough in advance to coordinate volunteers and have good weather
  - The rescheduled/rain date was sunny and hot, but occasional clouds and wind still caused temperature readings to dip
  - Site microclimates also caused lower or higher readings than expected given the location and land cover, resulting in outliers





# Future Study Potential

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- Stakeholders expressed interest in:
  - Repeating this study annually to track temperature increases over time, and
  - Concentrating on one of the major towns in the region to produce a more robust data set.
- To address the issue of limited volunteers, weather station data could possibly be used to supplement volunteer sampling data.





Rappahannock-Rapidan  
REGIONAL COMMISSION

# Questions?

Contact:

Michelle Edwards

[medwards@rrregion.org](mailto:medwards@rrregion.org)

Visit RRRC's Website for the full  
[Urban Heat Island Analysis Report](#)